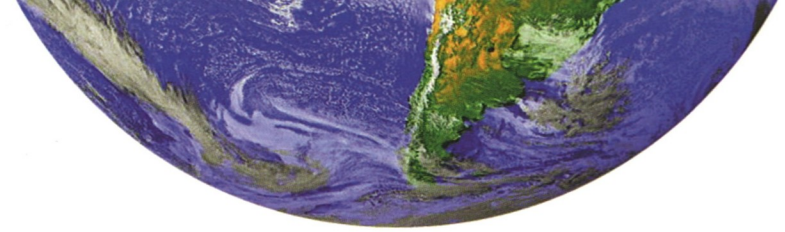
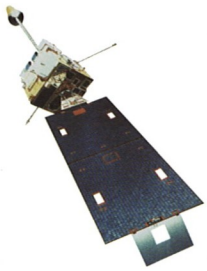
Product Guide

Silicon Graphics® Onyx2™



Combining the Ultimate in Visualization Technologies

This highly scalable system from SGI is the world's most powerful visual workstation, providing breathtaking performance for the most demanding visual computing challenges. Designed to simultaneously process 3D graphics, 2D imagery, and video data in real time, the Silicon Graphics® Onyx2™ family combines the ultimate in supercomputing and visualization technologies. Its groundbreaking performance and speed, record-setting bandwidth, and robust parallel compute technology establish Onyx2 in a class of its own. Configurable modules boast scalable system bandwidth and low-latency memory access while supporting a familiar programming environment. Whether it is supporting engineering, training, science, or entertainment, Onyx2 is the right technical computing platform for any organization planning to extend its leadership into the next century.



Unparalleled Capabilities Deliver Supreme Performance

Incorporating the richest, deepest feature set in the industry, Onyx2 stimulates creativity and profitability with unique tools such as clip-mapping, texture paging, volume rendering, multistream HDTV video manipulation, and multichannel, multioutput immersion support. These advanced visualization tools allow users to achieve astounding realism and exceptional dynamic rendering while improving and simplifying collaboration. Tap into numerous software and hardware products that harness the power of Onyx2 systems and today's high-performance MIPS® RISC processors, industry-proven Geometry Engine® technology, and exceptional development tools. Whether you want to expand your perception via visualization or make your first move into multiprocessor visual supercomputing, Onyx2 systems fit your needs and budget.

The Affordable Onyx2 Supercomputer

Along with extreme performance and an unmatched feature set, SGI also delivers affordability to empower budget-conscious commercial and academic teams. Scale your graphics, compute power, memory, storage, and networking capabilities to suit your application needs. Just as Onyx2 offers unmatched I/O bandwidth, it adds unmatched video I/O scalability for digital media excellence. Likewise, distributed applications can rely on the Onyx2 architecture, which meets all the demands of complex, collaborative virtual environments.

Onyx2 appears in compact deskside enclosures as well as highly scalable rack configurations. A rack system can be configured with multiple graphics subsystems driving either one rendered display for scalable graphics performance or multiple displays comprising an SGI™ Reality Center™ facility or visual simulator. The Onyx2 GroupStation, a rack system, can support up to 16 operators, each working with large data sets on dedicated displays while sharing the system's memory and bandwidth.

Supercomputing and

Onyx2 InfiniteReality2™
Multirack System
Supports up to 128 R12000™ processors and up to 16 visualization subsystems. Each subsystem can support one, two, or four Raster Managers and up to 320MB frame buffer.

- 256MB to 256GB system RAM
- Up to 2.3TB internal disk storage
- Unprecedented scalability of visual application performance; systems enabled with the DPLEX option or MonsterMode multipipe rendering software can deliver up to 200 million polygons per second, 7 billion pixels per second fill rate, and 1GB of physical texture memory to tackle the world's most challenging visual computing tasks
- Integrated audio and standard CD-ROM
- 24-inch SuperWide™, ultrahigh-resolution 1920x1200 monitor

Onyx2 InfiniteReality2
Deskside System
Supports one visualization subsystem with one or two Raster Managers and 64MB texture memory. Includes up to four R12000 processors with 4MB secondary cache.

- 80MB or 160MB frame buffer
- 256MB to 8GB system RAM
- Up to 90GB internal disk storage
- 13.1 million polygons per second
- Eight-sample anti-aliasing
- Integrated audio and standard CD-ROM
- Four I/O slots (optional PCI)
- 24-inch SuperWide, ultrahigh-resolution 1920x1200 monitor

Onyx2 InfiniteReality2
Single-Rack System
Supports up to eight R12000 processors and up to two visualization subsystems. One subsystem supports one, two, or four Raster Managers and up to 320MB frame buffer; the other supports one or two Raster Managers and up to 160MB frame buffer.

- 256MB to 16GB system RAM
- Up to 198GB internal disk storage
- 13.1 million polygons per second per pipeline
- Eight-sample anti-aliasing
- Integrated audio and standard CD-ROM
- Nine I/O slots (optional PCI)
- 24-inch SuperWide, ultrahigh-resolution 1920x1200 monitor

Onyx2 Reality™
Deskside System
For a great price you get up to four MIPS R12000 processors, 64MB of texture memory, up to 90GB of internal disk storage, and one Reality visualization subsystem with one or two Raster Managers.

- Up to 80MB frame buffer
- 256MB to 8GB system RAM
- 5.5 million polygons per second
- Four-sample anti-aliasing
- Integrated audio and standard CD-ROM
- Four I/O slots (optional PCI)
- 20-inch monitor

Energy

- Oil and gas: exploration and production

OpenGL Volumizer™ on Onyx2 allows exploration and production professionals to make better group decisions by interpreting larger amounts of data at higher resolution and in a more interactive manner. Reality Center facilities are being used in the industry for high-quality volume visualization of subsurface geography, resulting in greatly improved return on investment (ROI) by reducing survey interpretation time, increasing well placement accuracy, avoiding dry holes, and maximizing production from existing reservoir assets.

Government

- Visual systems for trainers
- Mission planning and rehearsal
- Imagery exploitation systems
- Command and control visual systems/C4I
- Ground Station

Only Onyx2 has the power and real-time visualization capability to concurrently process imagery, video, 3D terrain, and geospatial data. Onyx2 systems are used by governments around the world for flight, driving, and maritime simulation, mission planning and battlefield visualization, defense imaging, and intelligence. Whatever the application, Onyx2 is the preferred platform because of its unparalleled image quality, display resolution, ability to handle extremely large data sets, and support for real-time environments.

Sciences and Education

- Visual supercomputing
- Virtual reality
- Chemistry/pharmacology/biotechnology
- Medical research
- Multimedia art in education

Onyx2 systems are unequaled in laboratories for advanced scientific research and visual supercomputing. They are the only solutions that support integrated supercomputing performance with large memories, high-performance networking, multiple high-performance graphics pipelines, and multiple independent users. Whether visualizing correlations between therapeutic targets and disease, searching for synthetic compounds, or using Reality Center facilities to train surgeons through virtual surgery, the multidisciplinary approach of scientific research requires Onyx2. Only Onyx2 has the speed, power, and range of applications required for quicker time-to-insight in today's complex research environments.

Manufacturing

- Design review
- Engineering simulation
- Styling

Through advanced visualization capabilities and interactive real-time modeling, Onyx2 is changing the manufacturing industry. Engineers can now create digital prototypes in a fraction of the time it takes to build expensive physical models, saving money, reducing time-to-market, and improving safety. Using Reality Center solutions driven by Onyx2, engineering, procurement, and construction teams are able to use high-fidelity, real-time walk-throughs to visualize and interact with every part of a complex design, achieving consensus and avoiding costly mistakes before beginning construction.

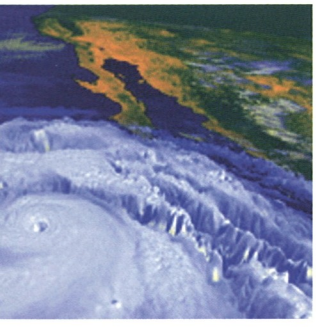
Entertainment/Media

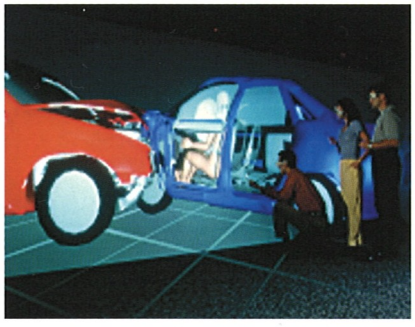
- Editing and compositing
- Broadcast graphics
- Interactive entertainment
- 3D modeling and animation

Onyx2 is the workstation of choice for high-end TV and film production/post-production, real-time broadcast effects, digital theme parks and other location-based interactive media, and real-time processing of high-definition satellite images. Its incredible processing speed and awesome bandwidth allow users to work with high-definition uncompressed video or film-resolution images, create multilayered 2D and 3D effects, or edit many simultaneous streams of standard or high-definition video—all in real time.

No matter what market you serve, the Onyx2 visual workstation helps you gain insight into the toughest problems.

Customers in a wide range of industries have harnessed the power of Onyx2 and Reality Center solutions to achieve—and exceed—their business objectives.



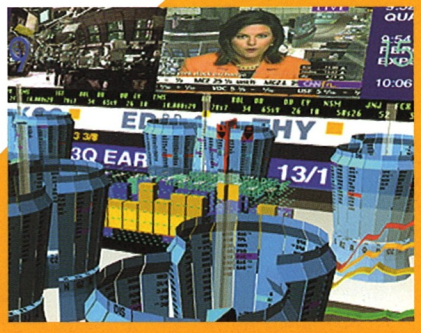


Services and Support to Help Businesses Succeed

The system becomes even more productive when our expert teams tailor setup, service, and support to match your unique computing requirements. SGI Global Services professionals work closely with organizations to ensure successful systems integration and maximum return on investment. A full complement of flexible, high-quality, cost-effective programs and services allows you to get the most out of your Onyx2 installation and increase your competitive edge.

Onyx2 for Supreme Perfo

It's one thing to be faster than other visual workstations. It's another to offer wholly unique capabilities. Onyx2 does both.



It is the only advanced visualization platform that doubles as a tightly coupled supercomputer—one equipped with superb media tools, such as digital audio for professional-quality sound, video reference input, a real-time graphics-to-video option, and a digital video option for routing multiple video and audio streams. Broadcast-quality video maps directly onto any 3D surface while image processing functions enhance the video stream in real time.

Exceptional Feature Set

Onyx2 operators consistently leverage a whole that is greater than the sum of its parts, tapping into the richest, deepest feature set anywhere:

- Interactive imaging of unbounded 3D volumes and unbounded 2D texture maps
- Data fusion: the ability to visualize scenes comprising 2D imagery, 3D polygons, and video with little or no performance penalty
- Real-time operating system support across application segments
- Integral support for virtual reality, real-time six degrees of freedom (6DOF) interaction, and sensory immersion
- Support for most display resolutions and out-of-the-box PCI compatibility with advanced interfaces, including force feedback, motion capture, telerobotics, stereoscopic display systems, and Reality Center facilities

mance and Flexibility

Expandability

By using high-bandwidth crossbar interconnects, the revolutionary Onyx2 architecture eliminates the bottleneck associated with bus-based designs. On Onyx2 rack systems, you can integrate additional modules any time you need more processing power, main memory, I/O connectivity, graphics, or system bandwidth. The high system bandwidth and low memory latency make it possible to combine multiple visualization subsystems into a single rendered display. This unprecedented capability delivers increased frame update rates for complex geometries and increased texture memory for massive volume rendering.

Flexibility for Peak ROI

An idle system earns no return on investment, so SGI designed Onyx2 to offer varied operating modes to keep it working around the clock. Employ Onyx2 as an interactive visualization station by day and a batch compute processing machine by night. Rack configurations offer several additional modes: multiuser GroupStation, multidisplay (for Reality Center facilities), and multipipe rendering (using the DPLEX hardware option or MonsterMode software) in which multiple InfiniteReality2 subsystems focus on a single rendering task. In most cases, you move from one mode to another by flipping a software switch; no hardware reconfiguration is required.

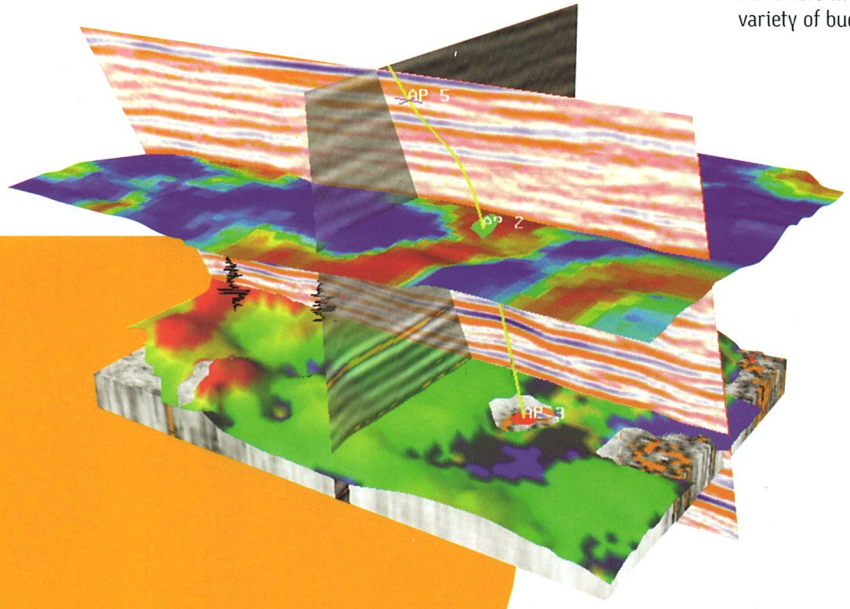
Onyx2 GroupStation: A New Pathway to Collaboration

Onyx2 GroupStation is the ideal solution for teams that need to interact with data sets that exceed the memory capacity, disk storage, and processing capabilities of desktop workstations. It can be configured for up to 16 independent operators to work with large models while sharing memory and bandwidth using the same machine. Faster application performance, massive local disk space, and unparalleled compute power make Onyx2 GroupStation the ultimate workgroup resource.

SGI Reality Center Immersive Visualization Facilities

In response to the trend toward collaborative work processes, SGI offers a complete line of standard and custom Reality Center solutions. SGI configurations range from benches and desks to large-screen walls and immersive rooms, each driven by the power of Onyx2. Many Reality Center facilities seamlessly integrate with off-the-shelf applications and utilize techniques such as stereoscopic viewing for more effective problem solving.

The strategic advantage conferred by group visualization has the proven ability to increase return on investment. SGI can help assess the needs of any organization, along with the likely benefits of adding Reality Center technology to its workflow. In addition, SGI offers complete turnkey solutions, including facility design, installation, integration, custom applications, and operator training. From simple to complex, standard to custom, SGI offers the broadest range of solutions to suit a wide variety of budgets and needs.



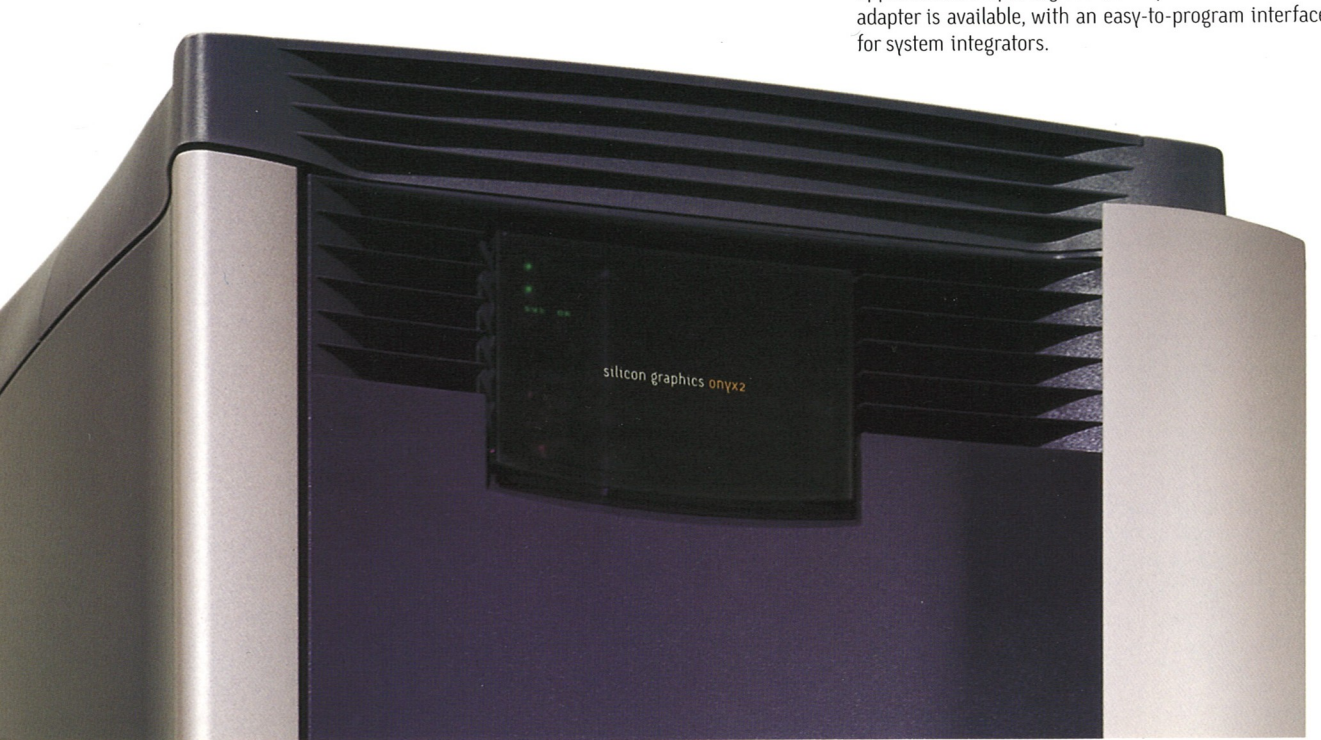
Distinctive Technologies D
Unprecedented Scalability

Drawing on a decade's experience in designing best-of-class multiprocessing supercomputers, SGI created an advanced implementation of ccNUMA (cache-coherent nonuniform memory access) architecture. This tightly coupled architecture with inherent scaling of system and graphics bandwidth is central to the Onyx2 system's breakthrough visual performance and feature set. It's why Onyx2 system-based simulators deliver the lowest transport latency in the industry plus the unique ability to handle continuous, real-time fly-overs of arbitrarily large, geospecific terrain (up to and including the entire globe). It's why Onyx2 supports preview at full film resolution. And it's why Onyx2 supports interactive, immersive visualization of "unbounded" volumes (e.g., the entire Visible Human) and full-product digital prototyping (entire cars, airplanes, factories). Thanks to the enormous bandwidth unique to ccNUMA, you can engage multiple InfiniteReality2 subsystems simultaneously, focusing incredible power on solving a single visual problem.

The heart of ccNUMA is the crossbar interconnect that moves data from CPUs and memory to every other part of the system: I/O, graphics, and other node boards. Each interconnect consists of eight bidirectional links. This means even the entry-level Onyx2 system boasts 6.4GB per second of bandwidth. Each processor and every megabyte of memory are seamlessly interconnected to form a single machine image. Adding CPUs and memory increases the bandwidth of the entire system. Adding visualization subsystems increases total host-to-graphics throughput.

High-Performance Connectivity: Seamless Integration with Your World

Onyx2 visual workstations feature versatile networking options, including industry-standard Ethernet, HIPPI, and FDDI interfaces. Fibre Channel and asynchronous transfer mode connections take network capabilities to a new level of communications performance. With unrivaled system bandwidth, I/O devices in Onyx2 systems operate at peak performance, avoiding bandwidth contentions among graphics, video, storage, and other I/O. The optional peripheral component interconnect (PCI) local bus gives Onyx2 systems access to a wide range of standard peripherals. The PCI bus supports 32-bit and 64-bit PCI boards with a peak bandwidth of 264MB per second. For applications requiring VME, an optional XIO VME adapter is available, with an easy-to-program interface for system integrators.



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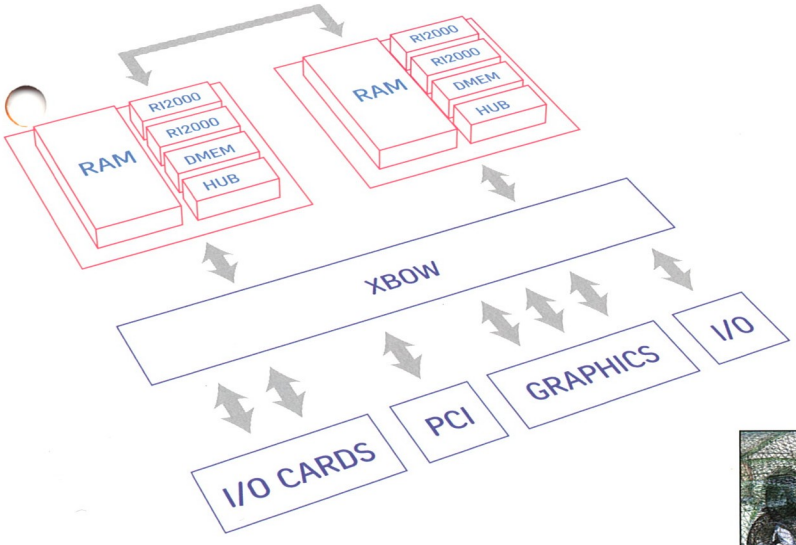
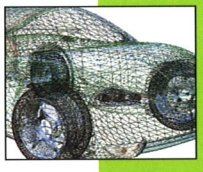


The high-speed bidirectional interconnects in a four-processor deskside Onyx2 system. Each node board communicates with other parts of the system via high-speed interconnects operating at 1.6GB per second, full duplex.

MIPS R12000: Extraordinary Power

The 64-bit MIPS R12000 processor is the engine that drives the blazing compute performance of Onyx2. This superscalar RISC CPU is the same processor used in the industry-leading SGI™ Origin™ server line.

- High clock rate accelerates every system function
- Four-way superscalar architecture, dynamic out-of-order instruction issue, and speculative execution maximize utilization of processing units
- Large nonblocking cache keeps essential data in fast memory



Visualization Pipeline Architecture

Geometry Engine

High-performance Geometry Engine processors perform lighting calculations and geometric transformations such as translation, rotation, and scaling. Geometry Engine processors also execute image processing functions such as convolution and histogram equalization, representing a more effective approach than that of CPUs.

Raster Managers

Raster Managers scan-convert data from Geometry Engine processors into digital images. Raster Managers perform pixel operations, including z-buffer testing, color and transparency blending, texture mapping, and multisample anti-aliasing, at real-time rates.

Display Generator

The Display Generator converts digital data from the Raster Managers into analog or digital video signals for display. A two-channel Display Generator provides one high-resolution analog output and a second high-resolution analog or NTSC/PAL output. An optional eight-channel Display Generator provides up to eight distinct analog outputs. There are several digital output options as well. Multiple channels are used to drive visual trainers, stereo devices, and other advanced interfaces.

Powerful AP

OpenGL: The Foundation for High-Performance Graphics

Application programmers access Onyx2 graphics through the industry-standard OpenGL environment to develop 2D and 3D graphics applications. The OpenGL API helps developers quickly and easily create advanced, portable graphics applications. OpenGL fosters innovation by providing low-level access to the advanced rendering capabilities of Onyx2.

Building with OpenGL Optimizer™

The award-winning OpenGL Optimizer development environment is a multiplatform toolkit providing higher-level constructs for interacting with extremely large geometric databases. Applications in CAD, CAM, CAE, digital prototyping, and AEC will achieve optimal graphics performance. The OpenGL Optimizer toolkit includes multiprocessing, occlusion culling, topological synthesis, and full support for all complex higher-order trimmed parametric curves and surfaces. These capabilities enable applications that provide efficient rendering performance while maintaining the underlying properties of the model. OpenGL Optimizer combined with Onyx2 revolutionizes complex surface evaluation with RealityMapping™.

Real-Time 3D Rendering with IRIS Performer™

IRIS Performer is the renowned 3D rendering toolkit for developers of real-time, multiprocessed, interactive graphics applications. IRIS Performer dramatically simplifies the development of complex applications in visual simulation, simulation-based design, virtual reality, interactive entertainment, broadcast video, and architectural walk-through. Your application can make automatic and optimal use of all available system features—including peak performance rendering, multiple CPUs, multiple graphics subsystems, filesystem and disk access, and real-time scheduling features. IRIS Performer provides efficient access to Onyx2 capabilities by automatically managing multiple levels of detail, paging of huge textures, and dynamic animated geometry.

s for Developers

Great hardware is only part of the solution. SGI provides a suite of application programming interfaces (APIs) to help you achieve the best performance with your hardware investment. The Onyx2 APIs were built on OpenGL®, the industry standard for graphics application development.

OpenGL Volumizer: A Breakthrough in Volume Imaging

OpenGL Volumizer is a revolutionary graphics API that facilitates visualization of voxel-based data sets common in geoscience, medical, and engineering applications such as CFD and finite element analysis, as well as those implementing physics-based models for special effects such as smoke, fog, and liquid. Developers can more easily create applications to display and manipulate volumetric data (along with geometric data if desired). Its use of tetrahedral primitives is an innovative and powerful approach to volume imaging.

ImageVision Library® AE Tools

For manipulating, processing, and displaying images, SGI offers ImageVision Library. ImageVision Library tools comprise a powerful development environment that provides more than 70 robust image operators optimized for use with multiple processors and Onyx2 hardware graphics acceleration. ImageVision Library provides functions for color conversion, geometric transformation, filtering and edge detection, graphics subsystem statistics, robust caching and data management functions, and debugging tools.

IRIX®

Onyx2 systems use the state-of-the-art, 64-bit SGI IRIX operating system, based on industry-standard UNIX® System V, Release 4 technology. With IRIX, Onyx2 users operate within a familiar shared-memory programming environment with backward compatibility for existing applications. At the same time, new capabilities support extensive scalability, high-availability features, and XFS.™

REACT™ Real-Time Performance

The REACT extensions for IRIX deliver deterministic performance for real-time applications. REACT tools give users control over system overhead, process priority, and processor allocation and scheduling; real-time disk access; and synchronization to external events.

Fahrenheit

SGI and Microsoft Corporation have formed a strategic alliance aimed at increasing the capabilities of visualization applications for a wide variety of customers. A goal is to develop ways to harness the power of SGI technology in the Windows NT® and IRIX environments. Toward that end, the companies are collaborating on a project named "Fahrenheit" to provide a common set of low-level and high-level APIs that integrate SGI and Microsoft concepts for visualization and graphics for their respective platforms. SGI and Microsoft are also working together to support the development of graphics applications for professionals through the industry-standard OpenGL API.

Onyx2 Technical Specifications

	Onyx2 Reality Deskside	Onyx2 InfiniteReality2 Deskside	Onyx2 InfiniteReality2 Rack Single-Pipe	Onyx2 InfiniteReality2 Rack 16-Pipe with Multipipe Rendering[†]
Graphics				
Polygons/sec	5.5M	13.1M	13.1M	210M
Pixel fill, smooth, Z	224M to 448M	224M to 448M	224M to 896M	7.2B
Pixel fill, textured, AA, Z	94M to 188M	192M to 384M	192M to 768M	6.1B
Anti-aliased vectors/sec	3.6M	8.6M	8.6M	138M
Trilinear interpolations/sec	100M to 200M	200M to 400M	200M to 800M	6.4B
Convolutions/sec (5x5 sep. RGBA)	6.4M	15.3M	15.3M	245M
Voxels/sec	100M to 200M	200M to 400M	200M to 800M	6.4B
24-bit floating-point Z	Yes	Yes	Yes	Yes
Color	48-bit RGBA	48-bit RGBA	48-bit RGBA	48-bit RGBA
Overlay planes	16	16	16	16
Anti-aliasing multisampling	4x4	8x8	8x8	8x8
Max. bits/pixel	128 to 512	256 to 2,048	256 to 2,048	256 to 2,048
Graphics pipelines	1	1	1 to 16	1 to 16
Geometry Engine processors/pipeline	2	4	4	4
Raster Managers/pipeline	1 to 2	1 to 2	1 to 4 and 1 to 2	1 to 4 and 1 to 2
Texture memory/pipeline	64MB	64MB	64MB	Up to 1GB combined texture memory capacity with MonsterMode software
Frame buffer size/pipeline	40MB to 80MB	80MB to 160MB	80MB to 320MB	80MB to 320MB
Display channels/pipeline	2 or 8	2 or 8	2 or 8	1[‡], 2, or 8
Display capability	VGA to HDTV	VGA to HDTV	VGA to HDTV	VGA to HDTV
Std. monitor size resolution	20" 1280x1024	24" 1920x1200	24" 1920x1200	24" 1920x1200
Computer Platform				
CPU	MIPS R12000	MIPS R12000	MIPS R12000	MIPS R12000
Quantity	2 to 4	2 to 4	2 to 8	4 to 128
Primary caches (ins./data)	32KB/32KB	32KB/32KB	32KB/32KB	32KB/32KB
Secondary cache	8MB	8MB	8MB	8MB
RAM	256MB to 8GB	256MB to 8GB	256MB to 16GB	256MB to 256GB
Disk storage (internal)	1 to 5 9.1GB or 18.2GB Ultra SCSI	1 to 5 9.1GB or 18.2GB Ultra SCSI	1 to 11 9.1GB or 18.2GB Ultra SCSI or 10 3.5" Fibre Channel	1 to 11 9.1GB or 18.2GB Ultra SCSI or 10 3.5" Fibre Channel per rack
Expansion slots	4 XIO slots standard and 3-slot PCI optional	4 XIO slots standard and 3-slot PCI optional	9 XIO slots standard and 3-slot PCI optional	9 XIO slots standard and 3-slot PCI optional per rack
Dimensions	24" L, 20" W, 26.5" H	24" L, 20" W, 26.5" H	39" L, 29" W, 73" H	39" L, 29" W, 73" H per rack
Weight (max. configuration)	215 lb (98 kg)	215 lb (98 kg)	800 lb (364 kg)	800 lb (364 kg) per rack
Standard monitor weight	71.6 lb (32.5 kg)	90.2 lb (41 kg)	90.2 lb (41 kg)	90.2 lb (41 kg)
Electrical and Power				
Voltage	100 to 120 or 200 to 240 VAC, 1 phase (configurations limited below 200 V*)	100 to 120 or 200 to 240 VAC, 1 phase (configurations limited below 200 V*)	200 to 240 VAC, 1 phase	200 to 240 VAC, 1 phase
Frequency	47 to 63 Hz	47 to 63 Hz	47 to 63 Hz	47 to 63 Hz
Power	2,300 W max at 208 V, 1,840 W max at 120 V	2,300 W max at 208 V, 1,840 W max at 120 V	4,750 W (compute and graphics module) or 5,050 W (two graphics modules)	4,750 W (compute and graphics module) or 5,050 W (two graphics modules) per rack
Heat dissipation	7,843 BTU/hr (208 V), 6,274 BTU/hr (120 V)	7,843 BTU/hr (208 V), 6,274 BTU/hr (120 V)	16,198 BTU/hr (compute and graphics module) or 17,220 BTU/hr (two graphics modules)	16,198 BTU/hr (compute and graphics module) or 17,220 BTU/hr (two graphics modules) per rack
Electrical service type	NEMA 5-20 (120 V) or NEMA 6-15 (208 V) (U.S. only)	NEMA 5-20 (120 V) or NEMA 6-15 (208 V) (U.S. only)	NEMA L6-30 (U.S. only)	NEMA L6-30 (U.S. only)
Noise	50 dBa	50 dBa	65 to 70 dBa	65 to 70 dBa

I/O Networking and Communication

Standard data	40MB/sec Ultra SCSI, 10Base-T/100Base-TX Ethernet, 4 460 kbaud asynchronous serial ports, 2 keyboard ports, 2 mouse ports, parallel port
Standard audio	2.75 ohm BNC AES/EBU stereo in/out, 2 optical ADAT 8-channel in/out, RCA phono jack stereo line-level input output, 3.5 mm stereo analog headphone output, mono microphone input jack
Optional data	XIO to PCI adapter (1 full-height, 2 double-height slots, 132MB to 264MB/sec), XIO to VME adapter (6U, 9U), FDDI single attach, FDDI dual attach, UTP FDDI, Token Ring, ISDN, high-speed synchronous serial, 100MB/sec Fibre Channel (2 ports), 40MB/sec Ultra SCSI (4 ports), 100Base-TX (4 ports) combined with 460 kbaud asynchronous serial (6 ports), ATMOC3 (4 ports), and ATMOC12, DIVO in/out (CCIR601, SMPTE 259)

Removable Media

Standard	CD-ROM
Optional	DDS-2 (DAT), 8 mm Exabyte, DLT tape

Environmental (nonoperating)

Temperature	-20 to +60°C (-4 to +140°F)
Humidity	10% to 95% noncondensing
Altitude	40,000 MSL

Environmental (operating)

Temperature	+5 to +35°C (+41 to +95°F) altitude 5,000 MSL +5 to +30°C (+41 to +86°F) altitude 10,000 MSL
Humidity	10% to 90% noncondensing

*Onyx2 Reality with 2 Raster Managers and 2 node boards or Onyx2 InfiniteReality Deskside with 2 Raster Managers or 2 node boards requires 200 VAC or greater

† 2 Raster Managers per pipe and DPLEX option

‡ 1 analog and 1 digital with DPLEX

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